December 1999 Highlights of the Pulsed Power Inertial Confinement Fusion Program

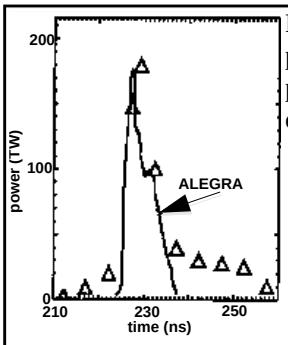

Fig. 1. Calculated x-ray power pulse with 2-D ALEGRA compared to measured power pulse on Z Shot 26.

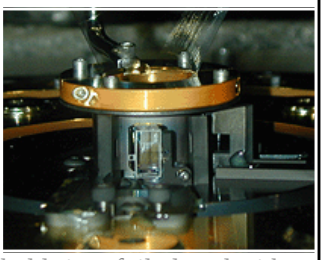

Fig. 2. Window-like frame holds iron foil, doped with NaF and sandwiched between plastic layers, for LDRD-funded experiments for LLNL on Z. Astrophysically-relevant iron plasmas in L-shell regime can be created.

There were 13 Z shots before the holidays. Z returns to full operation January 12 after scheduled maintenance. The shots included the first 3 short-circuit isentropic compression experiments with LLNL to produce shockless planar loading of surrogate material specimens (Mo, Ta, Be) in support of Campaign 2 objectives, 2 shots to prepare for these long-pulse experiments and to test sapphire and LiF windows, 5 shots to evaluate reproducibility of single and nested wire array sources, and one shot to evaluate ablatively-driven flyer plates for D_2 equation-of-state studies. On the last 2 shots, we began evaluating a small laser to backlight a diagnostic foam ball in a hohlraum to prepare for initial operation of the Z/Beamlet backlighter in December 2000.

To improve our ability to model wire-array dynamics, we have added new electrical conductivity tables to radiation-magnetodydrodynamic (R-MHD) codes. The tables include the metal-insulator transition region, at temperatures below a few eV and densities below solid. In this region, the commonly-used tables differ from the data by orders of magnitude. On Z, the prepulse current rises slowly, causing an exploding wire to spend significant time in this transition region. 2-D ALEGRA simulations of the x-ray power and pulse width on Z Shot 26 with the new tables are in reasonable agreement with the data (Fig. 1) except at the falling end of the pulse, where we have discovered a numerical problem and are working on correcting it. A comparison of density profiles, calculated using these improved conductivities, with experimental profiles will not be possible until Z/Beamlet is available. (Measured and calculated profiles for low-current Cornell experiments with an X-pinch backlighter were compared in the Sept. 99 *Highlights*.) In the meantime, we are developing tools to generate a pseudo-backlit image on ALEGRA.

A team from LLNL is collaborating with Sandia on laboratory astrophysics experiments on Z. Hardware from the initial experiment, in which x rays from imploding z pinches photoionized iron foils into the L shell, is shown in Fig. 2. Upcoming experiments will obtain detailed time- and space-resolved x-ray absorption and emission spectra from such foils. The data will benchmark models used by x-ray astronomers to interpret data from orbiting telescopes such as Chandra.

Z experiments to determine hohlraum energetics for the z-pinch-driven hohlraum in a single-sided geometry are in good agreement with radiosity and radiation-hydrodynamics calculations. Experiments with a surrogate capsule (foam ball) in the center of an attached, end-on hohlraum can diagnose the uniformity of the flux striking the ball (see Jan. 99 *Highlights*). Simulation of these experiments with 2-D LASNEX gives ablation rates and symmetry in good agreement with measurements near the peak of the radiation pulse; however, the early-time ablation of the ball is less than observed. We are exploring sources of this ablation, e.g., more prepulse radiation than is included in the modeling, or MHD expansion of residual plasma from the wire-array explosion that could cause erosion of the foam ball.

An analysis of Z shots since full energy operation began in 1996 has revealed shot-to-shot variations in the radiated energy of 11%, 7%, and 9%, respectively, as measured by x-ray diodes, bolometers, and calorimeters. The shot-to-shot variation in power is 13%, and the variation in pulse width is 8%. We are developing tools to understand the cause so that we will be able to reduce these variations.

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